

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
26 July 2001 (26.07.2001)

PCT

(10) International Publication Number
WO 01/53590 A1

(51) International Patent Classification⁷: **D04H 13/00**

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(21) International Application Number: **PCT/US01/00386**

(22) International Filing Date: 5 January 2001 (05.01.2001)

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(25) Filing Language: **English**

(81) Designated States (*national*): **JP, US.**

(26) Publication Language: **English**

(84) Designated States (*regional*): European patent (AT, BE,
CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,
NL, PT, SE, TR).

(30) Priority Data:
60/176,848 19 January 2000 (19.01.2000) US

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 01/53590 A1

(54) Title: NONWOVEN LAMINATE WIPING PRODUCT AND PROCESS FOR ITS MANUFACTURE

(57) Abstract: A nonwoven laminate product comprising a fine denier base web of thermoplastic material joined to a bulk layer and method of manufacture thereof. The bulk layer is preferably cellulosic material and more preferably wood pulp. The nonwoven laminate product has improved properties of strength, softness and drapability compared to conventional nonwoven laminate products.

NONWOVEN LAMINATE WIPING PRODUCT AND PROCESS FOR ITS MANUFACTURE

BACKGROUND OF THE INVENTION

5 This invention relates generally to nonwoven laminate products. More particularly, the present invention relates to nonwoven laminate products having a base web with a fine denier per filament.

10 As used herein, the term "nonwoven laminate product" comprises a multilayer product having a nonwoven "base" layer comprised of polymer fibers or filaments produced by an extrusion process and a nonwoven "bulk" layer, preferably of cellulosic material, joined thereto. As used herein, the term "nonwoven laminate product" excludes multiphase materials such as those described in United States Patent No. 2,414,833, wherein both of the phases or layers are deposited onto a foraminous 15 member from a dispersion.

20 The inventive nonwoven laminate product may be cut into individual wiping sheets. While the sheets may be used dry, more typically the individual sheets are saturated with a chemical solution suited for the intended end use, stacked and wrapped in a liquid tight package for subsequent dispensing. The chemical solution often includes bactericides and other biological control agents as well as emulsifiers, pH buffers, 25 perfumes and the like. The liquid tight packaging maintains the saturated condition of the wiping sheet.

Such wiping sheets, also called wet wipes or simply, wipes, are 25 commonly used by consumers for cleaning or wiping, particularly when wash water is not readily available or cannot be conveniently used. Travelers and parents of small children find such wipes especially 30 convenient. These wipes have been used for applying or removing makeup, cleansing parts of the body and as a substitute for conventional dry toilet paper. The wipes are also useful for household and industrial cleaning.

Current nonwoven laminate products have allowed the marketability to consumers of various desirable properties such as strength, softness, lotion distribution, cleanability and purity (i.e., lack of binder) in product applications such as baby wipes. As will be appreciated, these 5 premoistened wipes must also have sufficient wet strength to resist tearing and puncturing during vigorous use in the moistened state. While the existing products have been well received by consumers, there is a desire to improve the strength, softness and thickness of such current products.

10 DEFINITIONS

Bicomponent fibers - Fibers that have been formed from at least two polymers extruded from separate extruders through a single spinneret hole to form a single filament. The polymers are arranged in substantially constantly positioned distinct zones across the cross-section of the 15 bicomponent fibers and extend continuously along the length of the bicomponent fibers. The configuration of such a bicomponent fiber may be, for example, a sheath/core arrangement wherein one polymer is surrounded by another or a side by side arrangement.

Biconstituent fibers - Fibers that have been formed from a mixture of 20 two or more polymers extruded from the same spinneret. Biconstituent fibers do not have the various polymer components arranged in relatively constantly positioned distinct zones across the cross-sectional area of the fiber and the various polymers are usually not continuous along the entire length of the fiber, instead usually forming fibrils which start and end at 25 random. Biconstituent fibers are sometimes also referred to as multiconstituent fibers.

Cellulose fibers - Cellulosic fibers from natural sources such as 30 woody and non-woody plants. Woody plants include, for example, deciduous and coniferous trees. Non-woody plants include, for example, cotton, flax, esparto grass, sisal, abaca, milkweed, straw, jute, hemp, and bagasse.

Cross machine direction (CD) - The direction perpendicular to the machine direction.

5 **Denier** - A unit used to indicate the fineness of a filament. The unit expresses the mass of a filament divided by its length. A filament of 1 denier has a mass of 1 gram for 9000 meters of length.

Machine direction (MD) - The direction of travel of the forming surface onto which fibers are deposited during formation of a nonwoven web.

10 **Meltblown fibers** - Fibers formed by extruding a molten thermoplastic material as filaments from a plurality of fine, usually circular, die capillaries into a high velocity gas (e.g., air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly dispersed 15 meltblown fibers. Meltblown fibers are generally discontinuous. The meltblown process includes the meltspray process.

Non-thermoplastic - Any material which does not fall within the definition of thermoplastic material.

20 **Nonwoven fabric or web** - A web having a structure of individual fibers which are interlaid, but not in an identifiable manner as in a knitted fabric. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, and wet or dry laying processes. The basis weight of nonwoven fabrics is usually expressed in grams per square meter (gsm) and the fiber fineness 25 is measured in denier.

Polymer - Generally includes, for example, homopolymers, copolymers, such as, for example, block, graft, random and alternating copolymers, terpolymers, etc, and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" 30 includes all possible geometrical configurations of a material. These

configurations include, for example, isotactic, syndiotactic and random symmetries.

5 Spun filaments or fibers - Filaments formed by extruding molten thermoplastic materials from a plurality of fine, usually circular, capillaries of a spinneret. The diameter of the extruded filaments is then rapidly reduced as by, for example, eductive drawing and/or other well-known mechanisms. Spun filaments are generally continuous and have a denier range up to about 5 or more.

10 Thermoplastic - A polymer that is fusible, softening when exposed to heat and returning generally to its unsoftened state when cooled to room temperature. Thermoplastic materials include, for example, polyvinyl chlorides, some polyesters, polyamides, polyfluorocarbons, polyolefins, some polyurethanes, polystyrenes, polyvinyl alcohol, caprolactams, copolymers of ethylene and at least one vinyl monomer (e.g., poly (ethylene 15 vinyl acetates)), and acrylic resins.

SUMMARY OF THE INVENTION

Briefly stated, one aspect of the invention in preferred form is a nonwoven laminate or composite product including a bulk layer comprised 20 predominately of cellulosic fibers or pulp joined to a base web comprised of extruded fine denier fibers. The layers are preferably joined by hydroentanglement. The "fine denier" base web fibers have a denier of 1.5 or less, a preferred denier of 1.2 or less and a more preferred denier in the range of 0.5 to 1.2. The basis weight for the inventive nonwoven laminate 25 product is preferably less than 100 gsm and more preferably in the range of 35 to 75 gsm.

The base web fibers are comprised of extruded materials such as, for example, polyolefins (such as polyethylene or polypropylene), polyester, rayon, lyocell, acetate and acrylic. The base web fibers are preferably 30 extruded from a thermoplastic polymer. The base web is more preferably comprised of a layer of spunlaid and bonded substantially continuous

filaments preferably selected from at least one of the group consisting of polyolefin, polyester, and bicomponent polyethylene/polypropylene and bicomponent polyethylene/polyester. Bicomponent filaments are preferably in a lower melting point sheath/higher melting point core arrangement.

5 The base web has a preferred basis weight of less than 25 gsm and a more preferred basis weight in the range of 9 to 20 gsm. The base web preferably comprises between 20 and 60 percent of the resulting laminate product basis weight.

10 The bulk layer may be comprised of cellulosic fibers, cellulosic pulp, synthetic or other manmade fibers or mixtures of the above. The bulk layer is preferably comprised of cellulose fibers and more preferably wood pulp.

The bulk layer preferably comprises between 40 and 80 percent of the resulting nonwoven laminate product basis weight.

15 Another aspect of the invention is a preferred method for producing the inventive nonwoven laminate product, comprising providing a base web of fine denier fibers on a forming wire or conveyor. The base web is preferably preformed and placed over the conveyor. Alternatively, the base web may be extruded directly onto the conveyor. The bulk layer is deposited over the base web. The bulk layer may be deposited by, for 20 example, wet laying or air laying processes. It is also possible to deposit the bulk layer as a preformed tissue. The resulting fine denier base web with overlying bulk layer may optionally be passed below a compacting roll.

The base web/bulk layer composite, with or without compacting, is entangled, preferably by passage under a series of hydroentangling nozzles.

25 Water jets emitted from the nozzles impinge on the combined web material to hydraulically entangle the bulk layer fibers or pulp into the base web. The hydroentangled wet laminate material is placed under vacuum to remove a majority of water. The semi-dry laminate sheet material is preferably subjected to additional heated drying operations to further 30 remove remaining water, after which the finished nonwoven laminate product may be wound into a roll for subsequent handling.

5 The inventive nonwoven laminate product provides perceptible benefits. The fine denier spunbonded base web functions to provide a softer and more drapable nonwoven laminate product with a smoother surface than conventional nonwoven laminate products using higher denier base webs. The improved softness, drape and surface smoothness of the inventive nonwoven laminate products provides distinct advantages in the end-use marketplace. Additionally, the plastic content provided by the base web functions to enhance subsequent embossing of an image onto the end product, thereby improving its consumer appeal.

10 Despite providing increased softness and smoothness, the inventive nonwoven laminate products have surprisingly enhanced tensile and burst strengths when compared to conventional nonwoven laminate products of similar basis weights but having higher denier base webs. The enhanced strength of the inventive laminate product is beneficial in subsequent 15 manufacturing steps; during dispensing of a finished end-product, such as a baby wipe, from a storage container; and during usage of the wipe wherein the enhanced burst strength significantly reduces the "poke-through" associated with some conventional nonwoven laminate wiping materials during usage. The bulk layer provides a surface that is very useful 20 during an end use such as cleaning and helps lower manufacturing costs by substituting less expensive cellulose fiber or pulp in place of more expensive synthetic fibers. Additionally, the preferred wood pulp material, especially when airlaid, provides enhanced thickness to the resulting nonwoven laminate product.

25 An object of the invention is to provide a nonwoven laminate product that has enhanced properties of strength and softness.

Another object of the invention is to provide a nonwoven laminate product that has higher tensile and burst strengths than conventional nonwoven laminate products.

30 A further object of the invention is to provide a method of manufacture for improved nonwoven laminate products having increased

tensile and burst strength as compared to conventional nonwoven laminate products.

A better understanding of the invention will be obtained from the following detailed disclosure of the article and the desired features, 5 properties, characteristics and the relation of the elements as well as the process steps, one with respect to each of the others, as set forth and exemplified in the description and illustrated embodiments.

DESCRIPTION OF A PREFERRED EMBODIMENT

10 One preferred embodiment of the present invention comprises a nonwoven base web comprised of fine denier fibers joined to a bulk layer to form an inventive nonwoven laminate product. The invention does not exclude additional layers. The basis weight for the resulting inventive nonwoven laminate product is preferably less than 100 gsm and more 15 preferably about 35 - 75 gsm.

The nonwoven base web is comprised of extruded and bonded fine denier fibers. As used herein a "fine" denier filament or fiber has a denier of 1.5 or less, more preferably a denier of 1.2 or less and most preferably a denier within the range of 0.5 to 1.2. The nonwoven base web fibers are 20 comprised of extruded materials such as, for example, polyolefins (such as polyethylene or polypropylene), polyester, rayon, lyocell, acetate and acrylic. The base web fibers are preferably extruded from a thermoplastic polymer.

The base web is more preferably comprised of substantially 25 continuous spunlaid and bonded filaments. The base web filaments are comprised of a material preferably selected from at least one of the group consisting of polyolefin, polyester, and bicomponent polyethylene/polypropylene and bicomponent polyethylene/polyester. Bicomponent filaments, if present, are preferably in the form of a lower 30 melting point sheath and a higher melting point core.

The type of bonding of the base web material is not believed to be critical and may include, for example, solvent, adhesive, needle, hydroentanglement or thermal bonding. The base web component preferably has a basis weight of less than 25 gsm. More preferably the 5 base web has a basis weight in the range of 9 - 20 gsm. The base web component preferably comprises between 20% and 60% of the resulting nonwoven laminate product basis weight.

The bulk layer is generally comprised of cellulosic material. More 10 preferably, the bulk layer is cellulosic pulp and most preferably the bulk layer is wood pulp. Mixtures of various cellulose fibers and pulp may also be used. The bulk layer may include up to 25% synthetic or other manmade materials, for example, rayon, lyocell, polyester, polyolefin, polyamide, and bicomponent materials depending on the desired resultant bulk layer properties. The bulk layer preferably has a basis weight of less 15 than 75 gsm and more preferably a basis weight in the range of 25 to 60 gsm. The bulk layer preferably comprises between 40% and 80% of the resulting nonwoven laminate product basis weight.

A preferred method for producing the inventive nonwoven laminate product comprises providing a spunbond web of a substantially continuous 20 fine denier filaments on a foraminous conveyor. The fine denier spunbond base web is preferably preformed, although thermally processing the filaments directly onto the conveyor is within the scope of the invention.

Cellulosic material is deposited on top of the fine denier base web to form 25 the bulk layer. The cellulosic material may be deposited over the base web either dispersed in fluid (wetlaid) or in air (airlaid). It is also possible to deposit the bulk layer as a preformed tissue over the base web. It should be noted that deposition of the cellulosic material onto a conveyor or papermaking machine and placement of the spunbond base web over the cellulosic bulk layer is fully comprehended by the invention. Optionally, the 30 base web with deposited bulk layer is passed below a compacting roll.

The base web with deposited bulk layer is hydroentangled to provide

a resulting laminate sheet with desired tactile, absorption and strength characteristics. Preferably the hydroentanglement step is performed prior to a drying operation. Typically, the hydroentangling operation is a low to medium pressure hydroentangling operation as set forth in U.S. Patent No. 5,151,320 to Homonoff et al, the disclosure of which is incorporated by reference herein. While the Homonoff patent relates to a different nonwoven web material than the present invention, the hydroentangling operation described therein can efficaciously be employed with the present invention. Briefly, the hydroentanglement process preferably impinges a plurality of fluid jets onto the fibers of the bulk layer with sufficient force to cause a portion of the fibers therein to be propelled into and entangled with the base web layer. The fluid jets are preferably jets of an aqueous liquid. The entanglement process can be carried out on the conveyor using total energy input of about 0.1 to 0.4 horsepower-hours per pound of web (Hp-hr/lb). It should be understood that energy inputs greater than 0.4 Hp-hr/lb can be used in the practice of the invention.

The resultant hydroentangled wet laminate material is placed under vacuum to remove the majority of water. The semi-dried laminate sheet is further subjected to conventional heated drying operations, for example over heated dryer cans, to remove additional water. The drying process and temperature is controlled to achieve a desired level of fusion of the thermoplastic fibers. As an example, the drying temperature for nonwoven laminate products comprising a polyolefin base web is about 100 °C. After drying the finished nonwoven laminate product may be wound into a roll for subsequent handling, shipment and manufacture of end products.

The inventive nonwoven laminate product exhibits surprisingly increased tensile strength, in both the wet and dry condition, compared to conventional web materials of similar basis weight comprising higher denier base webs. As used herein tensile testing is conducted on a 1 inch (approximately 25 mm) wide by 5 inch long sample. The sample is placed in the jaws of a tensile testing instrument. Suitable tensile testing

instruments are available from Instron and Zwick. The tensile testing instrument applies a constant rate of extension of 5 inches per minute until the test sample breaks. A load cell is used to measure the force imposed on the sample at breakage. The force required to break the test sample is 5 reported in grams per 25 mm (gm/25mm). For wet tensile testing the sample is soaked in room temperature water. After soaking, the sample is blotted on a cotton blotter to remove excess water. Tensile strength may also be reported as total tensile strength, which is the sum of the MD and CD tensile strengths.

10 The inventive nonwoven laminate product further exhibits surprisingly increased burst strength, especially in the wet condition, compared to conventional web materials of similar basis weight comprising larger denier base webs. As used herein burst strength testing is conducted according to ASTM D3786.

15 Having generally described the invention, the following examples are included for purposes of illustration so that the invention may be more readily understood and are in no way intended to limit the scope of the invention unless otherwise specifically indicated. All parts are given by dry weight unless otherwise specified.

20

Example 1

Four nonwoven laminate products (samples 1-4) were produced generally following the above-described method. In all of the samples the base webs were comprised of spunlaid and bonded substantially continuous 25 filaments of polypropylene. In all of the samples Korsnaes treated wood fluff pulp was airlaid onto the respective base web. The resulting laminate materials were hydroentangled and dried conventionally using vacuum and heat.

30 Samples 1 and 2 comprised conventional nonwoven laminate products having a spunbonded base web wherein the filaments had an average denier of about 2.2. Samples 3 and 4 comprised inventive

nonwoven laminate products having a fine denier spunbonded base web wherein the filaments had an average denier of less than 1.2.

The base web of samples 3 and 4 comprised approximately 25% of the resulting total laminate basis weight of 74 g/m². Sample 2 had a similar 5 ratio of base web to wood pulp fiber to samples 3 and 4, while the base web of sample 1 comprised somewhat more wood pulp. The basis weight for the resulting laminate products was somewhat higher for sample 2 than for samples 1, 3 and 4, which were similar. The samples were tested for dry and wet tensile strengths in the machine direction (MD), the cross 10 machine direction (CD) and total tensile strength. The samples were also tested for wet Mullen burst strength. The properties of samples 1-4 are summarized in TABLE 1.

TABLE 1

	SAMPLE #1	SAMPLE #2	SAMPLE #3	SAMPLE #4
BULK LAYER				
Composition	wood pulp	wood pulp	wood pulp	wood pulp
% of total product	85	74	76	73
BASE WEB				
Composition	polypropylene	polypropylene	polypropylene	polypropylene
% of total product	15	26	24	27
dpf	2.2	2.2	<1.2	<1.2
NONWOVEN LAMINATE PRODUCT PROPERTIES				
Basis Weight g/m ²	75	83	74	74
Dry Tensile MD gm/25mm	2022	1842	3556	3250
Dry Tensile CD gm/25mm	641	829	1518	1444
Dry Tensile Total gm/25mm	2663	2671	5074	4694
Wet Tensile MD gm/25mm	1389	1004	3081	2825
Wet Tensile CD gm/25mm	315	568	1240	1396
Wet Tensile Total gm/25mm	1704	1572	4321	4221
Wet Mullen Burst gm/cm ²	802	1028	1513	1621

The fine denier base webs of samples 3 and 4 were perceptibly softer, smoother on the surface and more drapable than the conventional 5 higher denier base webs of samples 1 and 2. The improved softness, surface smoothness and drapability of the fine denier base webs functioned to provide the resultant inventive nonwoven laminate products of samples 3 and 4 with increased softness, drape, and surface smoothness as

compared to the conventional nonwoven laminate products typified by samples 1 and 2.

As can further be seen from Table 1, both inventive nonwoven laminate products (samples 3 and 4) exhibited significantly increased tensile strengths compared to conventional samples 1 and 2. The increases were achieved under both wet and dry conditions and in both the machine direction (MD) and cross machine direction (CD). Both inventive nonwoven laminate products (samples 3 and 4) also exhibited considerably increased burst strengths compared to conventional samples 1 and 2. The enhanced tensile and burst strengths are surprising and counterintuitive given the fine denier of the inventive base web fibers and the improved softness, drape and surface smoothness of the resulting nonwoven laminate products.

Additionally, both inventive nonwoven laminate products (samples 3 and 4) had a higher surface area and higher web uniformity as compared to the conventional nonwoven laminate products of samples 1 and 2. The higher uniformity of both inventive nonwoven laminate products (samples 3 and 4) was judged to make them more appealing with regard to appearance as a wiping product and to portray an image of higher quality as compared to conventional nonwoven laminate products. It should be noted that these advantages were obtained while maintaining substantially the same or lower basis weights as the conventional products. In fact, use of base webs having filaments with a denier of about 2.2 or greater was found to result in some amount of undesirable "splotchiness" in the final nonwoven laminate product.

While preferred embodiments of the foregoing invention have been set forth for purposes of illustration, the foregoing description should not be deemed a limitation of the invention herein. Accordingly, various modifications, adaptations and alternatives may occur to one skilled in the art without departing from the spirit and scope of the present invention.

What is Claimed is:

1. A composite nonwoven material of enhanced tensile strength including a nonwoven base web comprising thermoplastic fibers having a maximum denier of 1.5 and an additional layer overlying a surface of the base web and intimately entangled with the base web.
2. The material of claim 1, wherein the thermoplastic fibers have a denier within the range of 0.5 to 1.2.
3. The material of claim 1, wherein the thermoplastic fibers are comprised of a material selected from at least one of the group consisting of polyolefin, propylene, polyester, polyethylene/polypropylene and polyethylene/polyester.
4. The material of claim 1, wherein the thermoplastic fibers are substantially continuous spun filaments comprised of a material selected from at least one of the group consisting of polyolefin, polyester, polyethylene/polypropylene and polyethylene/polyester.
5. The material of claim 1 wherein said additional layer is a bulk layer.
6. The material of claim 1, wherein said additional layer is a bulk layer comprised of cellulose material.
7. The material of claim 1, wherein said additional layer is a bulk layer comprised of wood pulp.
8. The material of claim 1 having a basis weight wherein said base web comprises 20 to 60 percent of the basis weight.

9. The material of claim 1 having a basis weight of less than 100 grams per square meter.
10. The material of claim 1 having a basis weight within the range of 35 to 75 grams per square meter.
11. The material of claim 1, wherein the base web has a basis weight of less than 25 grams per square meter.
12. The material of claim 1, wherein the base web has a basis weight within the range of 9 to 20 grams per square meter.
13. A method of manufacturing a composite nonwoven material having enhanced tensile and burst strength comprising:
 - providing a nonwoven base web comprising thermoplastic fibers having a maximum denier of 1.5;
 - providing a layer adjacent the base web; and
 - entangling said adjacent layer with said base web to form the composite nonwoven material.
14. The method of claim 13, wherein said adjacent layer is provided in substantially dry form.
15. The method of claim 13, wherein said adjacent layer is provided as a predefined layer of nonwoven cellulose web material.
16. The method of claim 13, wherein said step of entangling comprises hydroentangling and further including a step of drying said hydroentangled composite nonwoven material.

17. The method of claim 13 further comprising the step of compacting the base web and the adjacent layer.
18. The method of claim 13, wherein the step of providing a nonwoven base web comprises spunbonding a thermoplastic material.
19. A nonwoven wipe material suited for wet use having a nonwoven base web comprising thermoplastic fibers having a maximum denier of 1.5 and cellulosic material intimately entangled with the base web, wherein the nonwoven wipe material has a tensile strength at least 1.5 times greater than a similar nonwoven wipe material having a base web comprised of filaments with a higher denier.
20. The wet wipe material of claim 19 having a wet tensile strength at least 2 times greater than a similar nonwoven wipe material having a base web comprised of filaments with a higher denier.

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D04H13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04H B32B D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

22 May 2001

Date of mailing of the international search report

31/05/2001

Name and mailing address of the ISA

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